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PENSOFT

First records of the jellyfishes *Thysanostoma loriferum* (Ehrenberg, 1837) and *Netrostoma setouchianum* (Kishinouye, 1902) in Hong Kong waters

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Abstract

Jellyfish have wide distributions throughout the world's oceans, with new species records emerging from increasingly broad areas as novel identification approaches are implemented, including citizen science. Here, the first accounts of *Thysanostoma loriferum* (Ehrenberg, 1837) and *Netrostoma setouchianum* (Kishinouye, 1902) in Hong Kong waters are reported based on photographs and videos collected by the Hong Kong Jellyfish Project. Together, these sightings obtained through a citizen science project provide evidence for a greater diversity of jellyfish in Hong Kong oceanic waters than has previously been recognized.

Keywords

citizen science, first record, Hong Kong Jellyfish Project, marine biodiversity, South China Sea, species distribution, species identification

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Introduction

Jellyfish are widely distributed throughout the world's oceans (Magalhães et al. 2020). Where present, jellyfish can influence ecosystems through their roles as efficient predators (Acuña et al. 2011), as prey for higher-order organisms (Pauly et al. 2009; D'Ambra et al. 2015), or as invading species (Fuentes et al. 2010). Moreover, jellyfish presence can have consequences for human activities (Doyle et al. 2007), with these impacts ranging from the closure of beaches and power stations, to declines in fishing catch levels or operations (Purcell et al. 2007).

The occurrence and ecosystem roles of jellyfish remain relatively poorly understood (Gibbons and Richardson 2013). That is, the impacts of this group are likely underestimated due to their widespread perception as bycatch (Rice et al. 2012), which has resulted in a lack of baseline data for many species (Doyle et al. 2007). It is worth noting, however, that some species are well studied, including the common and broadly distributed *Aurelia* spp. (Lamarck, 1816) (Jarms and Morandini 2019), the invasive *Mnemiopsis leidyi* (A. Agassiz, 1865) (Fuentes

et al. 2010), and the economically damaging *Pelagia noctiluca* (Forsskål, 1775) (Canepa et al. 2014). Developing a more comprehensive baseline understanding of the distribution and ecosystem roles of an increasingly diverse range of jellyfish will be important to our recognition of their impacts. This importance is accelerating as human activities drive changes in environments, such as overfishing, eutrophication, and climate change (Pitt et al. 2018), which could be creating conditions that facilitate jellyfish invasions and modify their abundances (Duarte et al. 2013).

Hong Kong, despite being part of one of the world's most species-rich marine areas (Ng et al. 2017), currently suffers from a lack of systematic documentation and maintenance of jellyfish species records. In terms of academic records, existing published articles about jellyfish in Hong Kong include a recent sighting (Ricca and Cheung 2021), an envenomation that occurred in Thailand and the victim returned to Hong Kong for treatment (Lam et al. 2014), and a report on jellyfish genetics (Nong et al. 2020). While often overlooked by researchers and fishers (Rice et al. 2012), this group of conspicuous organisms commonly attracts the attention of the general public. This attention may be leveraged to improve our understanding of Hong Kong's jellyfish. That is, citizen science has been successfully used to fill a similar research gap in the Mediterranean (Boero et al. 2009; Gatt et al. 2018). In recognition of this experience, a similar project has recently been launched in the waters around Hong Kong through the Hong Kong Jellyfish Project (HKJP) (https://www.hkjellyfish.com). Of sightings reported to the HKJP, one provides the first record of *Thysanostoma loriferum* (Ehrenberg, 1837) and another two provide the first records of *Netrostoma setouchianum* (Kishinouye, 1902) in Hong Kong. Here, we present a brief description of these records, notes on the occurrence of these species in Hong Kong, and highlight the benefits that can be gained from engaging citizen scientists in such projects.

Methods

To better understand the presence, abundance, and distribution of jellyfish in Hong Kong waters, a citizen science project—the Hong Kong Jellyfish Project (HKJP) (https://www.hkjellyfish.com)—was started in early 2021. This project engages watersports enthusiasts (swimmers, divers, kayakers, users of junk boats, etc.) across Hong Kong in seeking out and recording data about local jellyfish. In promoting the project, a species identification poster is shared through the HKJP website, social media, and in print. Reports, photographs, and videos of species included in the poster, as well as some not covered, are received through the HKJP website (https://www.hkjellyfish.com/share-a-sighting) and an iNaturalist project (https://www.inaturalist.org/projects/hong-kong-jellyfish-project). It is through these sources that records of two species of jellyfish not previously recorded in Hong Kong waters were made (Fig. 1). In addition to the photographs, videos, and location information, observers are asked to submit information including species name (if known), number of individuals, density, and the activity the observer was doing when the sighting occurred.

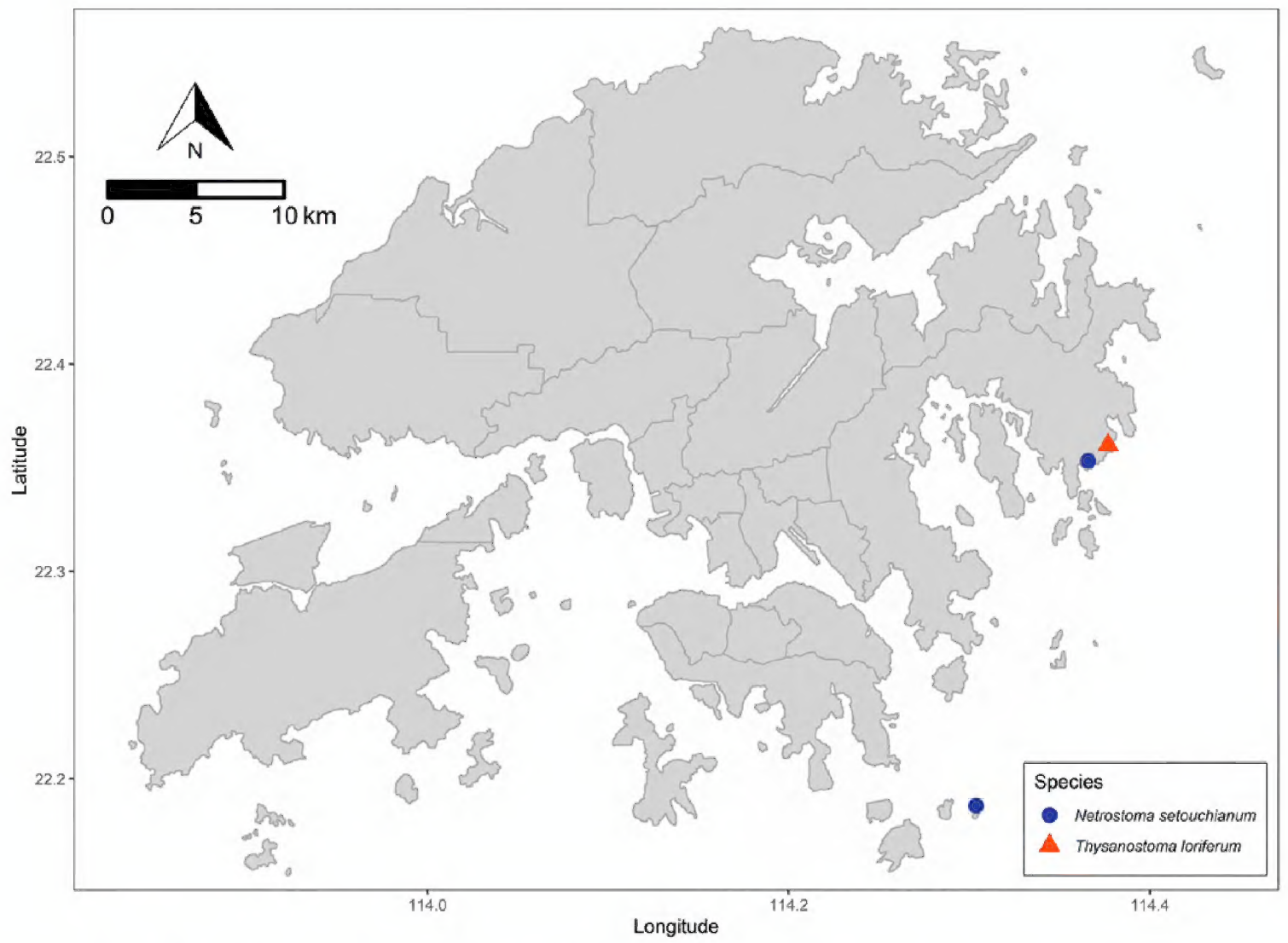

Figure 1. New records of the jellyfishes *Thysanostoma loriferum* (Ehrenberg, 1837) (red triangle) and *Netrostoma setouchianum* (Kishinouye, 1902) (blue circles) in Hong Kong waters.

Based on the information provided by citizen scientists, identification of these sightings was made with reference to previously published information, primarily Jarms and Morandini (2019). Further resources used for the *Thysanostoma loriferum* sighting included The Thysanostoma Project on the iNaturalist citizen science platform (Patry 2018), as well as Mayer (1910), Kramp (1961), and Cooke (1984). For the *Netrostoma setouchianum* sightings, reference was also made to Gershwin and Zeidler (2008), Kishinouye (1902), and Gul et al. (2015a).

Results

Thysanostoma loriferum (Ehrenberg, 1837)

Figure 2

New record. CHINA – **Hong Kong** • High Island Reservoir East Dam; 22°21′39.9″N 114°22′37.0″E; 5–6 m depth; 11 July 2021; Willie W.Y. San & Jennifer K.Y. Cheng obs.; 1 individual, sex undetermined.

Identification. The specimen diameter was approximately 150 mm, based on the diver's estimation using the known measurement of their aluminum pointer (330 mm). The entire length from the crown to end of tentacles was estimated by the diver as between 500–600 mm. The smooth bell was a strong blue, described for this species as "amethyst" by Mayer (1910), with an obvious cruciform internal tissue visible through the bell. The margins of the bell were white with dark violet spots on each of the marginal lappets, held together by a white membrane as described for this species in Cooke (1984) (Fig. 2B). The membrane (seen in Fig. 2C) connecting the marginal lappets is a feature that distinguishes *T. loriferum* from *T. flagellatum* (Cooke, 1984) and *T. thysanura* (Kramp, 1961). The eight long, purple-colored mouth-arms were covered in three rows of branched edges, which surround the millimeter-sized mouth openings along their length. The upper parts of the mouth-arms were complexly frilled and connected by arches between them, as described for this species in Mayer (1910) (Fig. 2C). There appears to be damage to the terminal appendages, with only one retaining what was described by Mayer (1910) as a "naked knob", another defining characteristic of *T. loriferum* (Fig. 2D). This feature helps distinguish *T. loriferum* from *T. thysanura*, which lacks the naked terminal portion (Kramp 1961).

Netrostoma setouchianum (Kishinouye, 1902)

Figures 3, 4

New records. CHINA – **Hong Kong** • Sai Kung East Country Park, Pak Lap Tsai; 22°21′11.8″N, 114°21′57.4″E; <5 m depth; 7 August 2021; Pak Hei Priscilla Ngai obs.; 1 individual; sex undetermined (sighting 1; Fig. 3) • West side of Waglan Island; 22°11′13.3″N, 114°18′13.8″E; 4 m depth; 25 July 2021; Cynthia Ho obs.; 1 individual; sex undetermined (sighting 2; Fig. 4).

Identification. Both sightings 1 and 2 were of individuals of a pale blue color, with a dome coming up from the exumbrella. The bell diameter of sighting 1 was estimated to be approximately 15 cm. A deep furrow ran around the umbrella separating the dome from the outer edge, which is characteristic of *Netrostoma* (Schultze, 1898) (Figs. 3B, 4A). Brown dots were visible on the individual from sighting 1 along the sides of the central

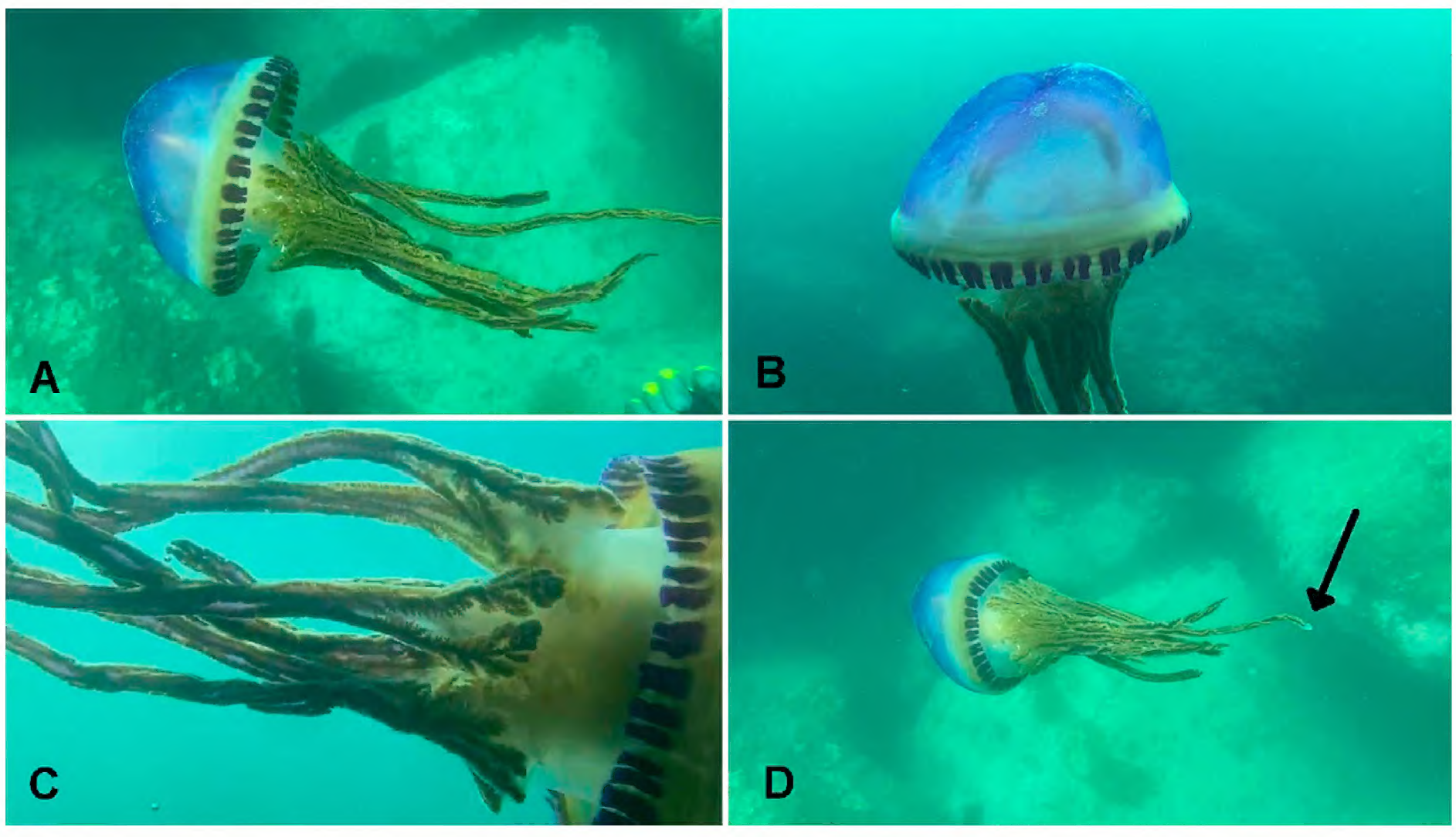

Figure 2. *Thysanostoma loriferum* sighted outside High Island Reservoir, Hong Kong. **A.** Entire animal. **B.** Bell margin. **C.** Upper parts of the mouth-arms. **D.** With the terminal appendage - "naked knob" - indicated by an arrow. Photographs by Willie W.Y. San and Jennifer K.Y. Cheng.

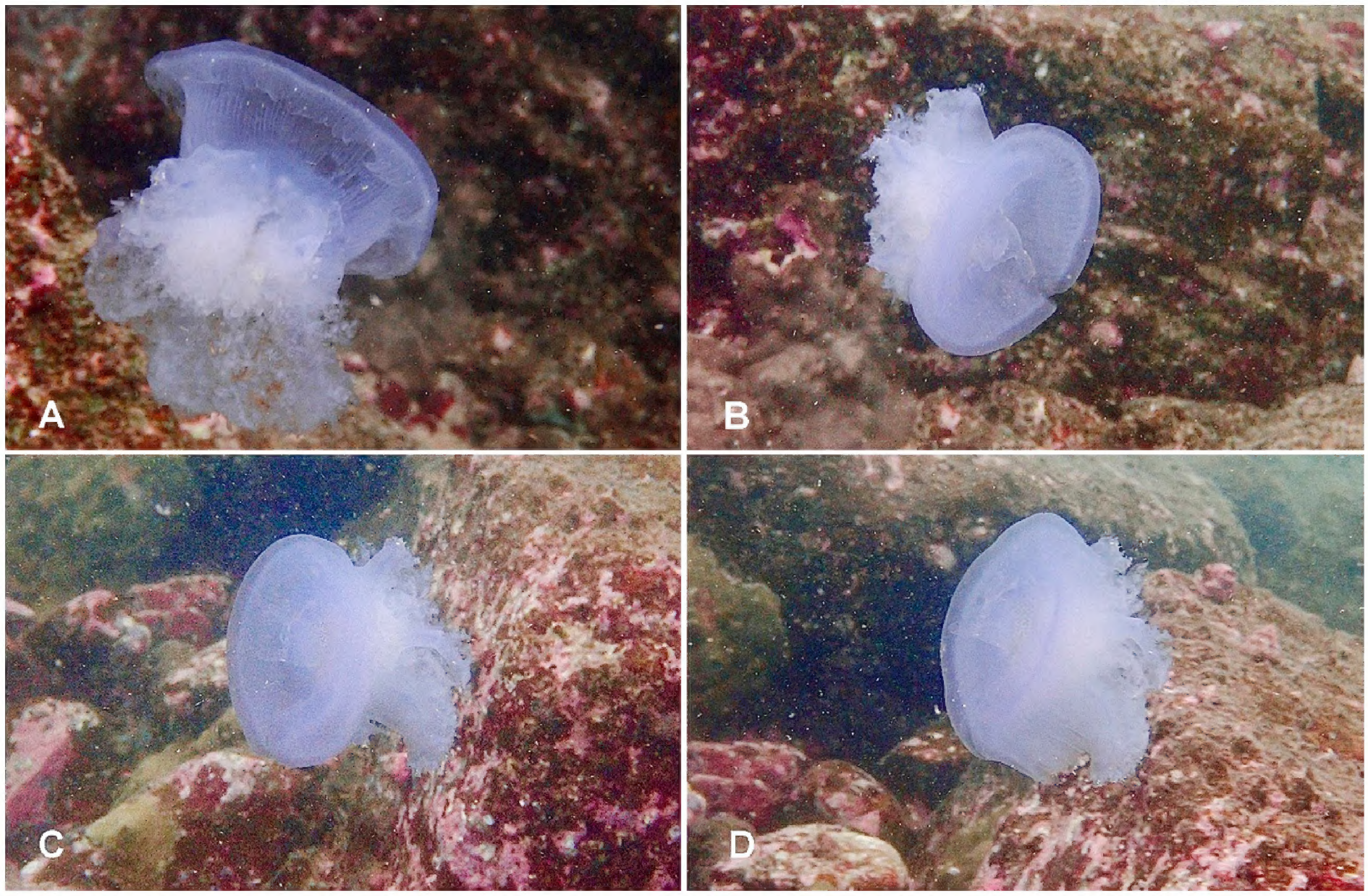

Figure 3. *Netrostoma setouchianum* (sighting 1), near the Sai Kung East Country Park, Hong Kong. **A.** Entire animal. **B.** The furrow that separates the dome from the outer edge. **C, D.** The pointed protuberances extending from the central dome and the oral arms which extend outwards and upwards toward the main body. Photographs by Pak Hei Priscilla Ngai.

dome of the umbrella as detailed for *Nestrostoma* by Kishinouye (1902) and Mayer (1910) (Fig. 3C, D), though these brown dots may not be a consistent feature across individuals within *Netrostoma* (Chuan et al. 2021). A number of pointed protuberances extended from the central dome of both individuals (Figs. 3B, C, 4A). These characteristics are present in the family Cepheidae, containing the genera *Cephea* (Péron & Lesueur, 1810) and *Netrostoma*. *Netrostoma setouchianum* has been identified by the pointed protuberances on the central knob (Gul et al. 2015a), and can be differentiated from other *Netrostoma* species by the large number of pointed protuberances from the dome at the center of the exumbrella. *Netrostoma nuda* (Gershwin & Zeidler, 2008) has a single round knob in the center, while *N. coerulescens* (Maas, 1903) has six large protuberances and numerous smaller wart-like bumps (Jarms and Morandini 2019). The other genera of Cepheidae, *Marivagia* (Galil & Gershwin, 2010) and *Cotylorhiza* (Agassiz, 1862), either lack a central dome or protuberances. The main difference between the genera of *Netrostoma* and *Cephea* are the number of gastrovascular canals between the rhopaliar canals, with this being three in the former and more than three in the latter. Another feature that distinguishes *Netrostoma* from *Cephea* is the lack of long filaments attached to the oral arms of *Netrostoma* (Gul et al. 2015a). For these sightings, the oral arms extended distally from the oral disk in their lower half (Figs. 3C, 4B, C) and were divided into two at the end, with multiple branchlets giving them a feather-like appearance, as described for *Netrostoma* by Kishinouye (1902).

Discussion

Here we report the first records of *Thysanostoma loriferum* and *Netrostoma setouchianum* in Hong Kong waters. More specifically, this sighting of *T. loriferum* is the first record of this species in the northern South China Sea, and is approximately 500 km from its nearest sighting in the Philippines, as shown on the iNaturalist platform. This sighting adds a further record to the geographic range of *T. loriferum*, although it has been reported from the Red Sea and around the Indo-Pacific from the Malay Archipelago to the Philippines (Kramp 1961), with more recent records documenting it in the Gulf of Eilat, Israel (Zakai and Galil 2001), in Hawaiian waters (Cooke 1984), and along the east coast of India (Sarkar 2003). Additionally, a citizen science project on the iNaturalist platform, the Thysanostoma Project by Wyatt Patry of the Monterey Bay Aquarium (Patry 2018), shows 50 *Thysanostoma* sightings worldwide, from Malaysia and the Philippines, north to Japan, and along the coasts of Africa and Australia. The two sightings of *N. setouchianum* reported here are the first records for this species in the northern South China Sea from the iNaturalist platform. These sightings can be considered within the expected range of this species (Jarms and Morandini 2019); the type locality is in Japan

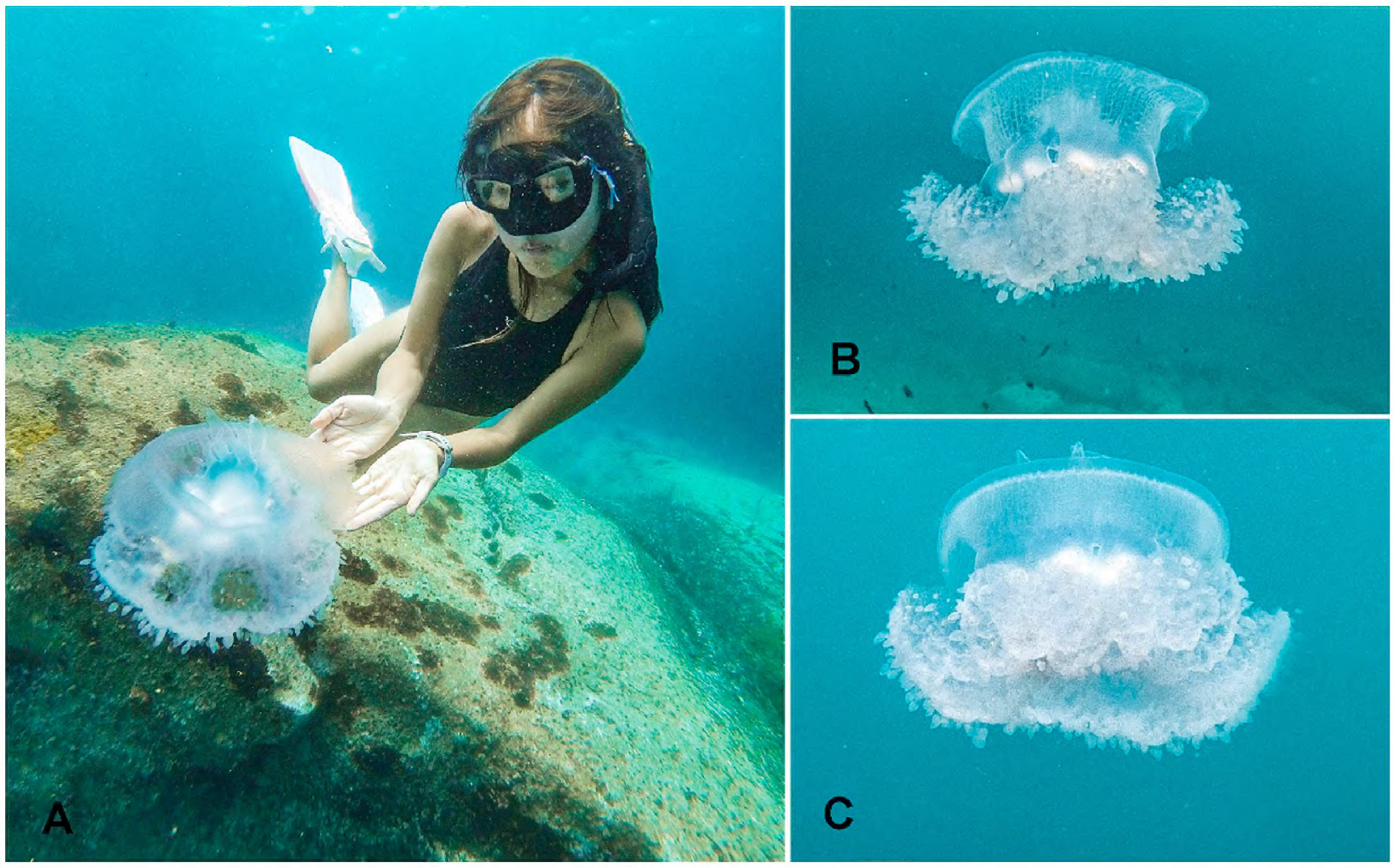

Figure 4. *Netrostoma setouchianum* (sighting 2), sighted near Waglan Island, Hong Kong. **A.** Entire animal and furrow that separates the dome from the outer edge and the pointed protuberances extending from the central dome. **B, C.** The oral arms which extend outwards and upwards toward the main body. Photographs by Cynthia Ho.

(Kishinouye 1902). Species within the genus *Netrostoma* are known to occur from the Indian Ocean and throughout the Indo-Pacific (Kramp 1961), and have been more recently reported in Pakistani waters (Gul et al. 2015b). As of September 2021, the citizen science platform iNaturalist shows 18 sightings of *Netrostoma* from India to Australia and to the Marshall Islands and Japan (iNaturalist 2021).

In addition to providing information about the current distribution of these jellyfish species, the reported sightings may give insight as to the environmental factors that determine the occurrence of these species. It is possible that recent weather was instrumental to the presence of in Hong Kong; there were east to southeast winds of force 4–5 on the Beaufort scale for several days prior to the 11 July 2021 sighting (Hong Kong Observatory, data.gov.hk) which may have propelled this individual towards the eastern coast of Hong Kong. Though normally an oceanic species, this individual was spotted in 5–6 m of water (Willie San pers. comm.). In contrast, *N. setouchianum* is likely present in Hong Kong waters as a consequence of the coastal currents of China and the larger currents entering the northern South China Sea. Together, these results highlight that further research is required to understand the effects of environmental variables on specific jellyfish distributions locally.

Citizen science has allowed us to capture evidence of these first sightings of two jellyfish species within Hong Kong waters, highlighting the applicability of such an approach. Now their presence is recognized, more could be done moving forward. Specifically, while the photograph and video records shared by citizen scientists provide occurrence and basic morphological information, care should be taken when relying solely upon photographs and videos for identification purposes due to the potential difficulties in morphologically distinguishing among congeners. Further targeted sampling could be conducted to gain physical specimens so that additional analyses—including, for example, fine scale morphological measurements and genetic analyses—can be conducted. While we note this potential, given the limitations of depending solely upon institutional research, we again emphasize that our results demonstrate citizen science is an effective way of obtaining new species records and adding to the knowledge of the distributions of little-known species.

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Authors' Contribution

Conceptualization: JT, LJF. Data curation: JT. Funding acquisition: JT, LJF. Investigation: JT. Methodology: JT. Visualization: JT. Writing – original draft: JT. Writing – review and editing: JT, LJF.

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